Final Exam

1) A) Image 1 - Blurred (loss of edges)
   B) Image 2 - Salt and Pepper noise
   C) Image 3 - Contrast is too similar across Entire imag

2) A) Image 3 - Contrast is too similar
   - Contrast Streching
     $P_{out} = (P_{in} - c)\left(\frac{b-a}{d-c}\right) + a$
     where c = max amplitude found in image
     where d = min amplitude found in image
     where b = upper bound (255)
     where c = lower bound (0)

   - Gamma Correction
     $\text{Corrected} = \left(\frac{\text{Pixel}}{255}\right.$
   - γ value of 3.5 will suffice.

   B) Image 2 - Salt and pepper noise
   - Median Blur
     - (3x3) Kernel will work
   - Adaptive Filtering
     - σ_n^2 = variance of overall noise
     - σ_g^2 = local mean of the kernel overlap
     - Kernel size of 7x7

2) c) Image 1 - Blurred

-Sharpening - create a sharpening filter by subtracting identity kernel from edge kernel

$$\underset{\text{identity}}{\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}} - \underset{\text{edge}}{\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}} = \underset{\text{Sharpen kernel}}{\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}}$$

- then convolve the original image with the Sharpen kernel

- Bilateral Filtering

pixel neighborhood = 9 (depends on src result)

Sigma color = 75 (color space)

Sigma space 75 (coordinate space)

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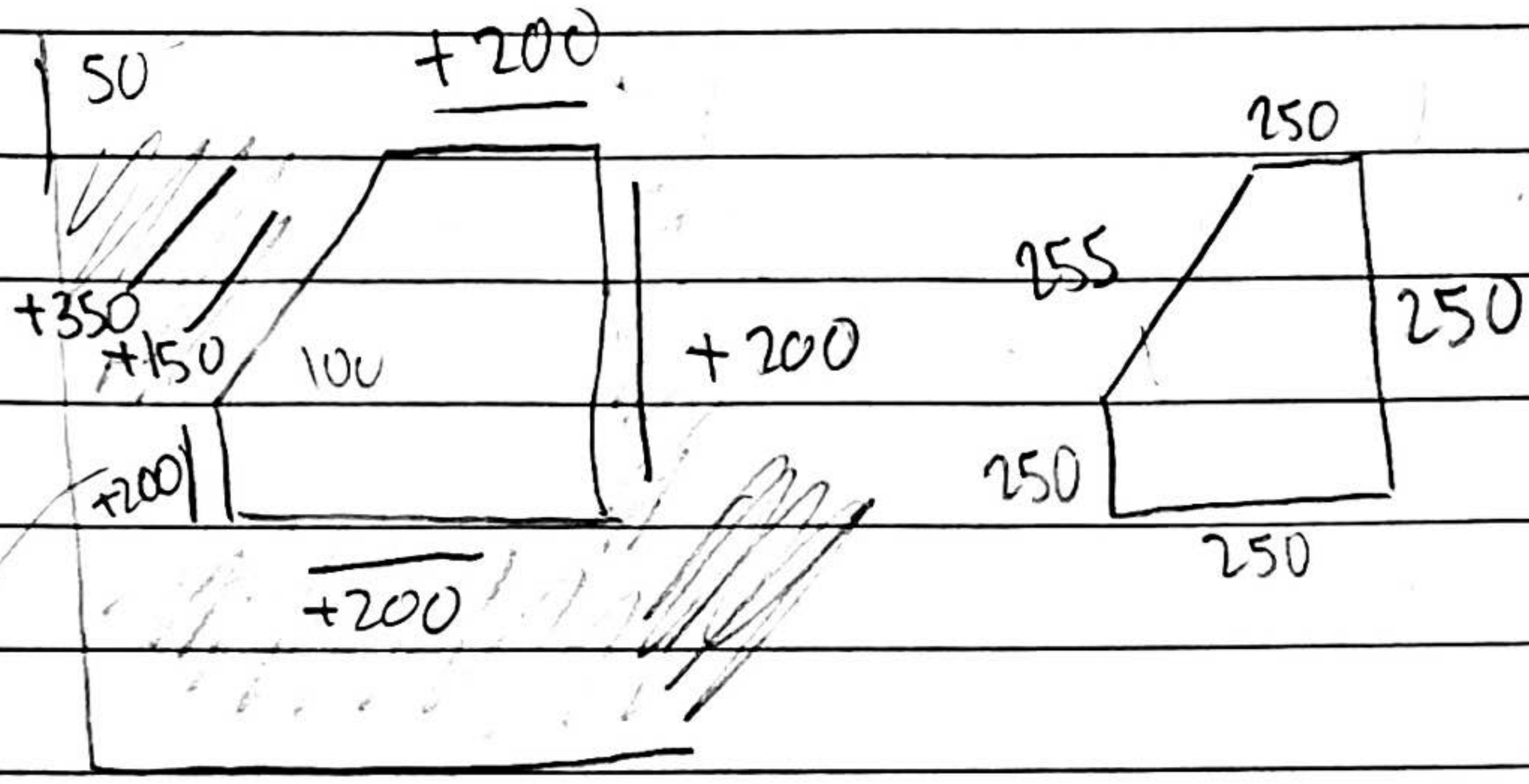
2) 1) Sobel

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \qquad \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ 1 & 0 & 1 \end{bmatrix}$$



Vertical $R1 = 50 \} R_2 = 250/300$ Horizontal

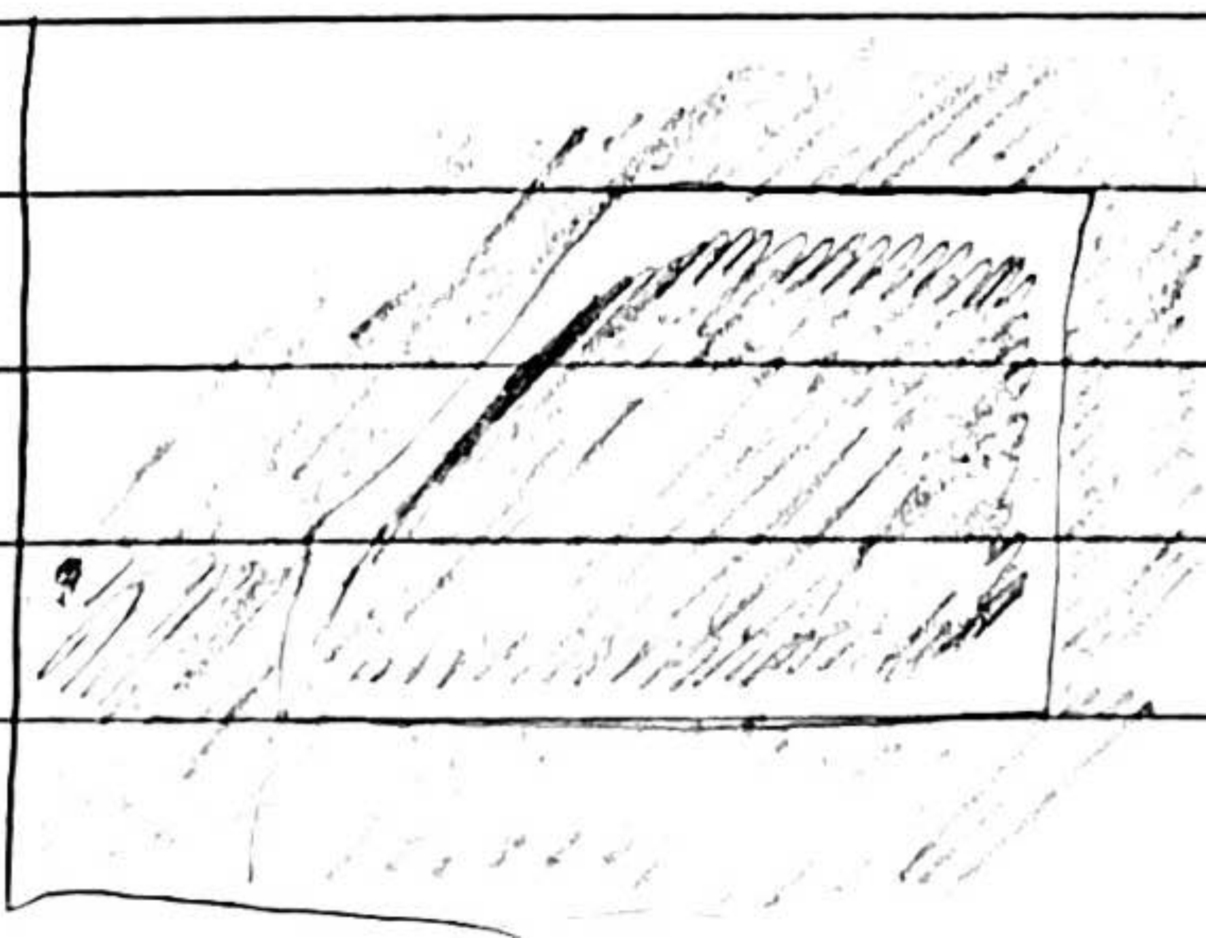
5

50	50	50	50	50	100
50	50	50	50	50	100
50	50	50	50	50	100
50	50	100	50	100	100
50	50	100	100	100	100
50	50	100	100	100	100

$R1 = 150$
$R2 = 350$
500

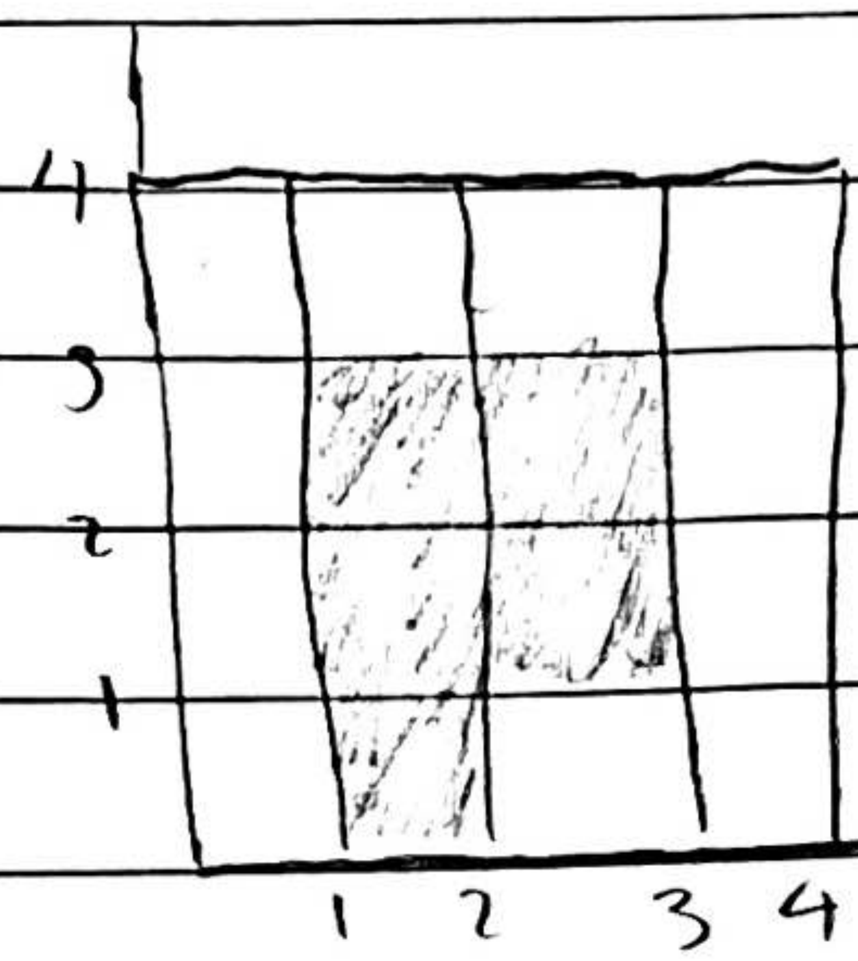
$R1 = 0$
$R2 = 200$
200

2) Laplacian



4) The difference between sobel and laplacian is that laplacian intends to find the edges and make them stand out. On the other hand, sobel will end up with 2 segmented areas, each with their own color (0, 255). In laplacian, the objects do not differ in color, only the edges. In the last example, sobel will result in an image where the shape is a different color than foreground, while laplacian will only segment the edge and make everything else black

Final Exam



3) 1) Run Length

N1	N2	Run
1	3	2
1	2	2
1	1	2
1	0	1

2) Quad Tree

A) G, G, G, G

B) $\boxed{W, W, W, B}$; $\boxed{WWBW}$; $\boxed{WBWB}$; $\boxed{BWWW}$

G; G, G, G; WWWB, WWBW; WBWB, BWWW

$e^{\frac{-j2\pi kn}{N}}$

3) Fourier

$1,1 = (1+j)e^{-j\frac{2\pi}{9}}$ $33 = (3+3j)e^{-j\frac{18\pi}{9}}$ $20 = (2)$

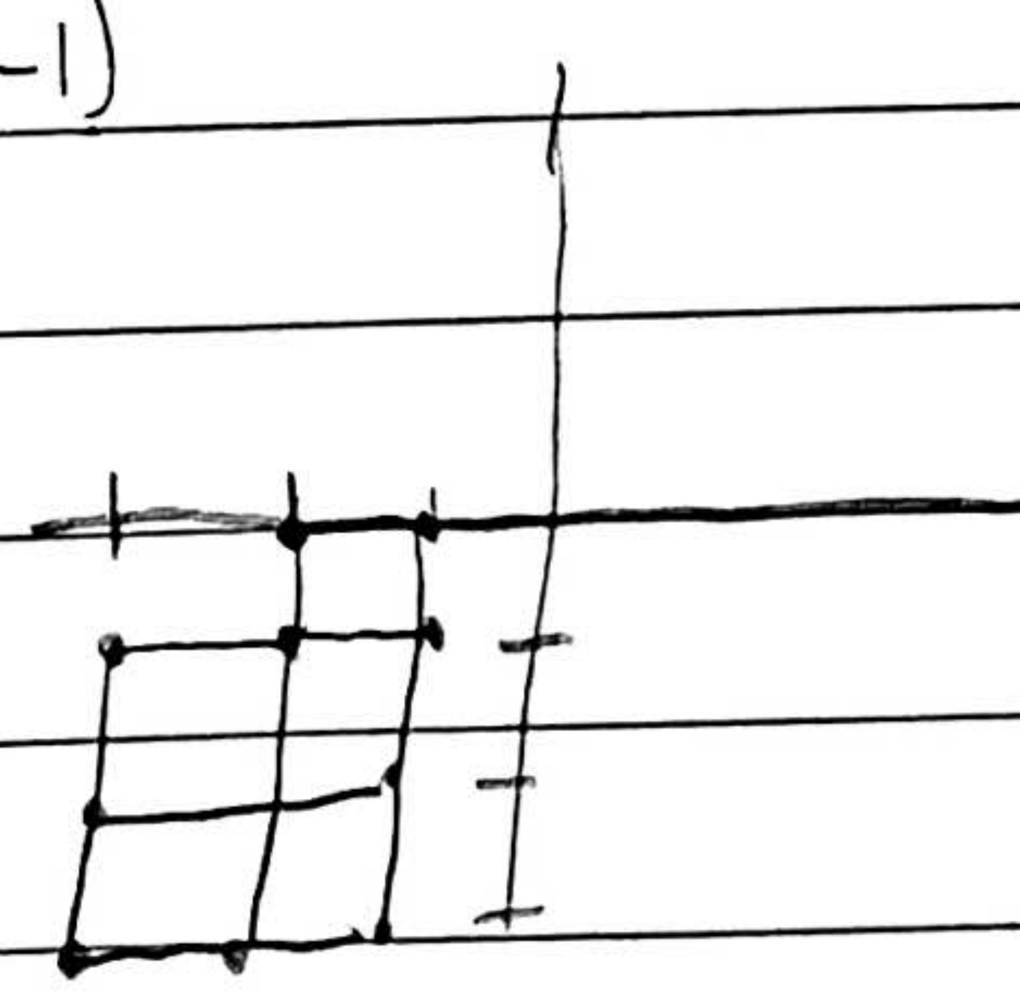
$12 = (1+2j)e^{-j\frac{4\pi}{9}}$ $32 = (3+2j)e^{-j\frac{12\pi}{9}}$

$13 = (1+3j)e^{-j\frac{6\pi}{9}}$ $31 = (3+j)e^{-j\frac{12\pi}{9}}$

$23 = (2+3j)e^{-j\frac{12\pi}{9}}$ $21 = (2+j)e^{-j\frac{4\pi}{9}}$

$1,0 = (1)$

4) (-1, -1), (-2, -1), (-3, -1) (-3, -2) (-3 -3) (-2 -3) (-1 -3) (-1 -2)
(0, -2) (0, -1)



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4) 1) The PSF will result in a loss of 66% across signal respones in $x[n_1]=1$, $x[n_1,n_2]=0$ and $x[n_1]=-1$

2) $x_d = x[n_1,n_2] ** h[n_1,n_2] + \overset{=0}{n[n_1,n_2]}$

$x[n_1,n_2]$ $\qquad$ $h[n_1,n_2] =$

$$G(w_1,w_2) = \frac{1}{|H(w_1,w_2)|} = \left|\frac{1}{1-\frac{1}{3}e^{-jw_1}}\right| = \sqrt{\frac{17}{16} - \frac{1}{3}\cos(w_1)}$$

3) $$G(w_1,w_2) = \frac{H^*(w_1,w_2)}{|H(w_1,w_2)|^2 + P_{nn}(w_1,w_2)/P_{xx}(w_1,w_2)} = \frac{\frac{1}{1-\frac{1}{3}e^{-jw}}}{\sqrt{\frac{17}{16}-\frac{1}{3}\cos(w_1)}+1}$$

5) Motion

(0,0) (0,0) (1,-1) (0,0) (0,0) (0,0) (0,0)

(0,0) (2,0) (1,-1) (0,0) (0,0) (0,0) (0,0)

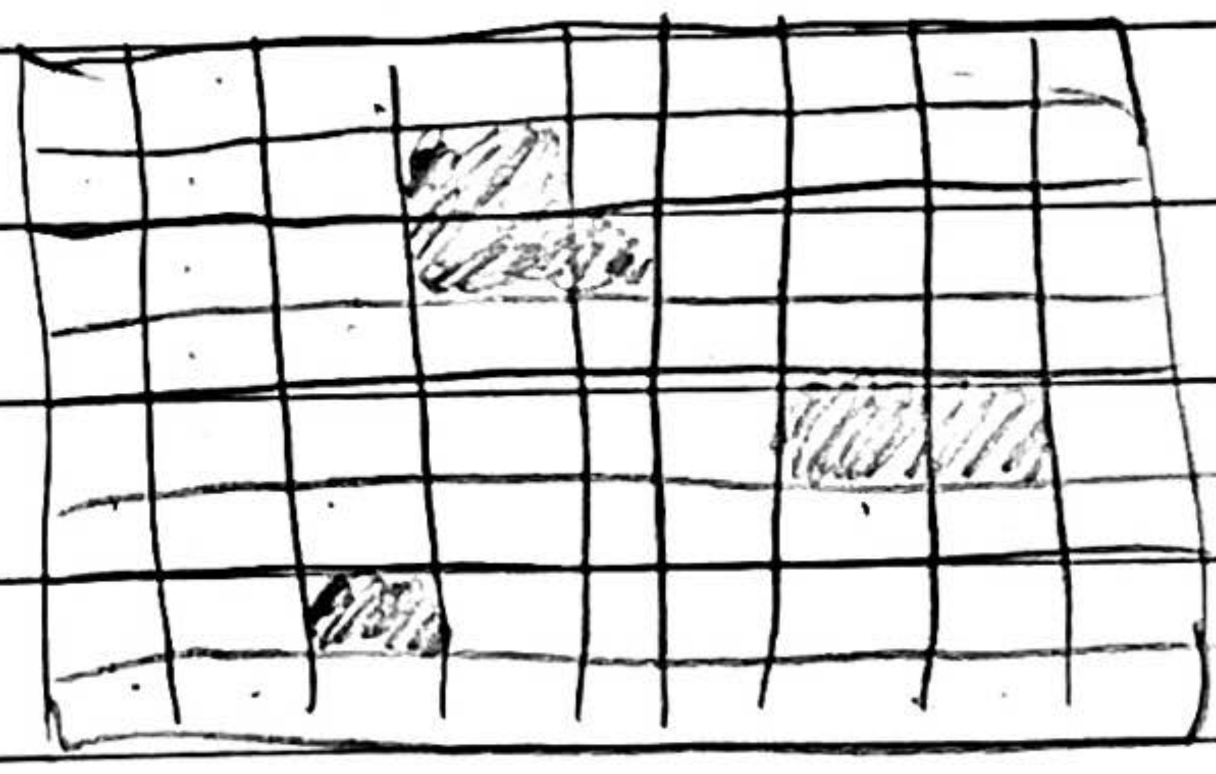
(0,0) ⟶

(0,0) (0,0) (0,0) (0,0) (0,0) (0,-1) (0,0)

(0,0) ⟶

(0,0) (1,-1) (0,-2) (0,0) (0,0) (0,0)

Prediction



Residual